CLAIMS:

1. A code stream producing apparatus comprising:

a quantizer that quantizes a frequency component obtained from a pixel value of an image through discrete wavelet transform to produce a set of quantized coefficients for each of a plurality of tiles of the image;

a block processing unit that divides the set of quantized coefficients into a plurality of blocks;

a hash conversion unit that carries out hash conversion for each of the blocks, based on the quantized coefficients of the block, to obtain an encoding hash value for each of the blocks;

a bit plane defining unit that divides each of the blocks into a plurality of bit planes;

a digital watermarking unit that adjusts an ON/OFF state of significant bits such that the relation between information defined by N (N is an even number) significant bits Qnm(x, y) (x=0, 1, …, y=0, 1, …) of the m^{th} bit plane of the n^{th} block and a natural number T satisfies either the ON state expressed by equation (1), or the OFF state expressed by equation (2), depending on whether the encoding

hash value of the n^{th} block is odd or even, in order to embed a digital watermark; and

an encoding unit that encodes the set of quantized coefficients containing the ON/OFF adjusted significant bits.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qnm(ik, ik) \right| - \left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm(ik, ik) \right| > T \quad \cdots (1)$$

$$\left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm(ik, ik) \right| - \left| \sum_{k=1}^{\frac{1}{2}N} Qnm(ik, ik) \right| > T \quad \cdots (2)$$

2. A code stream producing apparatus comprising:

a quantizer that quantizes a frequency component obtained from a pixel value of an image through discrete wavelet transform to produce a set of quantized coefficients for each of a plurality of tiles of the image;

a block processing unit that divides the set of

quantized coefficients into a plurality of blocks;

a hash conversion unit that carries out hash conversion for each of the blocks, based on the quantized coefficients of the block, to obtain an encoding hash value for each of the blocks;

a bit plane defining unit that divides each of the blocks into a plurality of bit planes;

a digital watermarking unit that adjusts the ON/OFF state of significant bits such that the relation between information defined by N (N is an even number) significant bits $Qnm_j(x, y)$ (x=0, 1, …, y=0, 1, …) of the m_j-th bit plane of the n^{th} block and a natural number T satisfies either the ON state expressed by equation (3), or the OFF state expressed by equation (4), depending on whether the encoding hash value of the n^{th} block is odd or even, in order to embed a digital watermark; and

an encoding unit that encodes the set of quantized coefficients containing the ON/OFF adjusted significant bits.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qnm_k(ik, ik) \right| - \left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm_k(ik, ik) \right| > T \quad \cdots (3)$$

$$\left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm_k(ik, ik) \right| - \left| \sum_{k=1}^{\frac{1}{2}N} Qnm_k(ik, ik) \right| > T \quad \cdots (4)$$

3. A code stream producing apparatus comprising:

a quantizer that quantizes a frequency component obtained from a pixel value of an image through discrete wavelet transform to produce a set of quantized coefficients for each of a plurality of tiles of the image;

a block processing unit that divides the set of quantized coefficients into a plurality of blocks;

a hash conversion unit that carries out hash conversion for each of the blocks, based on the quantized coefficients of the block, to obtain an encoding hash value for each of the blocks;

a bit plane defining unit that divides each of the blocks into a plurality of bit planes;

a digital watermarking unit that adjusts the ON/OFF state of significant bits such that the relation between information defined by N (N is an

even number) significant bits $Qn_im_j(x, y)$ ($x=0, 1, \ldots$, $y=0, 1, \ldots$) of the m_j-th bit plane of the n_i-th block and a natural number T satisfies either the ON state expressed by equation (5), or the OFF state expressed by equation (6), depending on whether the encoding hash value of the n_i-th block is odd or even, in order to embed a digital watermark; and

an encoding unit that encodes the set of quantized coefficients containing the ON/OFF adjusted significant bits.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qn_km_k(ik, ik) \right| - \left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_km_k(ik, ik) \right| > T \quad \cdots (5)$$

$$\left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_km_k(ik, ik) \right| - \left| \sum_{k=1}^{\frac{1}{2}N} Qn_km_k(ik, ik) \right| > T \quad \cdots (6)$$

4. The code stream producing apparatus according to any one of claims 1 through 3, wherein the digital watermarking unit carries out the ON/OFF adjustment

of the significant bits in one of a first mode, in which the relation between the natural number T and the bit information defined by significant bits is adjusted to the ON state when the encoding hash value is odd and to the OFF state when the encoding hash value is even, and a second mode, in which the relation between the natural number T and the bit information defined by significant bits is adjusted to the ON state when the encoding hash value is even and to the OFF state when the encoding hash value is odd.

5. The code stream producing apparatus according to claim 4, further comprising a mode setting unit that selects one of the first and the second modes in a switchable manner, wherein the digital watermarking unit determines the ON/OFF state of the bit information according to the selected mode.

6. The code stream producing apparatus according to claim 5, wherein the mode setting unit selects one of the first and second modes based on the encoding hash value and a coordinate value of a currently processed quantized coefficient on the image.

7. The code stream producing apparatus according to claim 5, wherein the mode setting unit selects one of the first and second modes based on the encoding hash value and externally input secret information.

8. The code stream producing apparatus according to claim 4, wherein the encoding unit performs an encoding operation from a higher bit plane to a lower bit plane, and wherein all the associated bits in bit planes lower than a current bit plane to be processed are made OFF when turning an OFF bit into the ON state, and all the associated bits in the bit planes lower than the current bit plane are made ON when

turning an ON bit into the OFF state.

9. The code stream producing apparatus according to claim 4, further comprising a coefficient selecting unit that selects a part of the quantized coefficients, wherein the digital watermarking unit carries out the ON/OFF adjustment of the significant bits for the selected part of the quantized coefficients.

10. The code stream producing apparatus according to claim 9, wherein the coefficient selecting unit selects one of the quantized coefficients that has a difference from an adjacent one of the quantized coefficients equal to or greater than a prescribed threshold value.

11. The code stream producing apparatus according to claim 10, wherein the threshold value is embedded in the quantized coefficients.

12. The code stream producing apparatus according to claim 4, wherein the hash conversion unit carries out the hash conversion using at least one of externally input secret information, date information, and a manufacturing number of the code stream producing apparatus, in addition to the quantized coefficients.

13. An image processing apparatus that receives and decodes a compressed code stream, the apparatus comprising:

a decoding unit that decodes the code stream to produce a set of quantized coefficients;

a block processing unit that divides the set of quantized coefficients into a plurality of blocks;

a decoding hash conversion unit that carries out hash conversion for each of the blocks, based on the quantized coefficients of the block, to obtain a decoding hash value for the block;

a bit plane defining unit that analyzes the quantized coefficients of each of the blocks into bit planes; and

an unauthorized use detecting unit that determines whether an odd/even property represented by either an ON state, in which a relation between a natural number T and bit information defined by N (N is an even number) significant bits Qn_im_j (x, y) (x=0, 1, …, y=0, 1, …) of the m_j-th bit plane of the n_i-th block satisfies equation (7), or an OFF state, in which the relation between the natural number T and the bit information satisfies equation (8), matches an odd or even value of the decoding hash value of the n_i-th block to detect unauthorized use.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qn_km_k(ik, ik) \right| > \left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_km_k(ik, ik) \right| \quad \cdots (7)$$

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qn_km_k(ik, ik) \right| < \left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_km_k(ik, ik) \right| \quad \cdots (8)$$

14. The image processing apparatus according to claim 13, further comprising an emphasizing display unit that emphasizes the block in which the odd/even property matches the odd/even characteristic of the decoding hash value when displaying a decoded image.

15. A code stream producing program installed in a computer to cause the computer to execute the procedures of:

dividing an image into a plurality of tiles;

performing discrete wavelet transform on image data of each of the tiles to convert each of pixel values of the image to a frequency component;

quantizing the frequency components to produce a set of quantized coefficients;

dividing the set of quantized coefficients into a plurality of blocks;

performing hash conversion for each of the blocks,

based on the quantized coefficients of the block, to obtain an encoding hash value for the block;

dividing each of the blocks into a plurality of planes;

adjusting an ON/OFF state of significant bits such that a relation between information defined by N (N is an even number) significant bits Qnm(x, y) (x=0, 1, …, y=0, 1, …) of the m^{th} bit plane of the n^{th} block and a natural number T satisfies either the ON state expressed by equation (1), or the OFF state expressed by equation (2), depending on whether the encoding hash value of the n^{th} block is odd or even, in order to embed a digital watermark; and

encoding the set of quantized coefficients containing the ON/OFF adjusted significant bits.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qnm(ik, ik) \right| - \left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm(ik, ik) \right| > T \quad \cdots (1)$$

$$\left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm(ik, ik) \right| - \left| \sum_{k=1}^{\frac{1}{2}N} Qnm(ik, ik) \right| > T \quad \cdots (2)$$

16. A code stream producing program installed in a computer to cause the computer to execute the procedures of:

dividing an image into a plurality of tiles;

performing discrete wavelet transform on image data of each of the tiles to convert each of a plurality of pixel values of the image to a frequency component;

quantizing the frequency components to produce a set of quantized coefficients;

dividing the set of quantized coefficients into a plurality of blocks;

performing hash conversion for each of the blocks, based on the quantized coefficients of the block, to obtain an encoding hash value for the block;

dividing each of the blocks into a plurality of bit planes;

adjusting an ON/OFF state of significant bits such that a relation between information defined by N (N is an even number) significant bits $Qnm_j(x, y)$ (x=0, 1, …, y=0, 1, …) of the m_j-th bit plane of the n^{th} block and a natural number T satisfies either the ON

state expressed by equation (3), or the OFF state expressed by equation (4), depending on whether the encoding hash value of the n^{th} block is odd or even, in order to embed a digital watermark; and

encoding the set of quantized coefficients containing the ON/OFF adjusted significant bits.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qnm_k(ik, ik) \right| - \left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm_k(ik, ik) \right| > T \quad \cdots (3)$$

$$\left| \sum_{k=\frac{1}{2}N+1}^{N} Qnm_k(ik, ik) \right| - \left| \sum_{k=1}^{\frac{1}{2}N} Qnm_k(ik, ik) \right| > T \quad \cdots (4)$$

17. A code stream producing program installed in a computer to cause the computer to execute the procedures of:

dividing an image into a plurality of tiles;

performing discrete wavelet transform on image data of each of the tiles to convert each of a plurality of pixel values of the image to a frequency

component;

quantizing the frequency components to produce a set of quantized coefficients;

dividing the set of quantized coefficients into a plurality of blocks;

performing hash conversion for each of the blocks, based on the quantized coefficients of the block, to obtain an encoding hash value for the block;

dividing each of the blocks into a plurality of bit planes;

adjusting an ON/OFF state of significant bits such that a relation between information defined by N (N is an even number) significant bits $Qn_im_j(x, y)$ (x=0, 1, …, y=0, 1, …) of the m_j-th bit plane of the n_i-th block and a natural number T satisfies either the ON state expressed by equation (5), or the OFF state expressed by equation (6), depending on whether the encoding hash value of the n_i-th block is odd or even, in order to embed a digital watermark; and

encoding the set of quantized coefficients containing the ON/OFF adjusted significant bits.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qn_k m_k(ik, ik) \right| - \left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_k m_k(ik, ik) \right| > T \quad \cdots (5)$$

$$\left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_k m_k(ik, ik) \right| - \left| \sum_{k=1}^{\frac{1}{2}N} Qn_k m_k(ik, ik) \right| > T \quad \cdots (6)$$

18. The code stream producing program according to any one of claims 15 through 17, wherein the program causes the computer to carry out the ON/OFF adjustment of the significant bit in one of a first mode, in which the relation between the natural number T and the bit information defined by significant bits is adjusted to the ON state when the encoding hash value is odd and to the OFF state when the encoding hash value is even, and a second mode, in which the relation between the natural number T and the bit information defined by significant bits is adjusted to the ON state when the encoding hash value is even and to the OFF state when the hash

value is odd.

19. An image processing program installed in a computer and causing the computer to execute the procedure of:

receiving and decoding a compressed code stream to produce a set of quantized coefficients;

dividing the set of quantized coefficients into a plurality of blocks;

carrying out hash conversion for each of the blocks, based on the quantized coefficients of the block, to obtain a decoding hash value for the block;

dividing the quantized coefficients of each of the blocks into a plurality of bit planes; and

determing whether an odd/even property represented by either an ON state, in which a relation between a natural number T and bit information defined by N (N is an even number) significant bits Qn_im_j (x, y) (x=0, 1, …, y=0, 1, …) of the m_j-th bit plane of the n_i-th block satisfies equation (7), or an OFF state, in which the relation between the natural number T and the bit information

satisfies equation (8), matches an odd or even value of the decoding hash value of the n_i-th block to detect unauthorized use.

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qn_k m_k(ik, ik) \right| > \left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_k m_k(ik, ik) \right| \quad \cdots (7)$$

$$\left| \sum_{k=1}^{\frac{1}{2}N} Qn_k m_k(ik, ik) \right| < \left| \sum_{k=\frac{1}{2}N+1}^{N} Qn_k m_k(ik, ik) \right| \quad \cdots (8)$$

20. The image processing program according to claim 19, further causing the computer to execute the procedure of:

displaying a decoded image, while emphasizing a block location in which the odd/even property matches the odd/even characteristic of the decoding hash value.